Research Report
KTC-98-13

FIELD PERFORMANCE REPORT ON 1219 MM HDPE (48-INCH) ON US 127 OWEN COUNTY

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in cooperation with
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Commonwealth of Kentucky

and

Federal Highway Administration
U.S. Department of Transportation

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16. Abstract.

This report documents the installation and performance of a 1219 mm (48-inch) corrugated smooth lined polyethylene (HDPE) pipe installed during reconstruction of US 127 in Owen County. The pipe installed was manufactured by Advanced Drainage Systems, Inc., and is designated as ADS N-12. pipe.

The culvert was installed in a 6-meter (20-foot) high embankment. The culvert pipe was installed in two sequences. The first half of the structure was bedded and backfilled with No. 8 stone and the second half of the structure was bedded and backfilled with pipe sand (crushed limestone).

The pipe appears to be performing well. The average deflection is approximately 1.0 to 1.5 percent. The maximum deflection recorded was 2.5 percent.

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EXECUTIVE SUMMARY

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INTRODUCTION

The Kentucky Transportation Center was requested by the Kentucky Transportation Cabinet to monitor the construction and field performance of a corrugated, smooth-lined, 48-inch polyethylene pipe cross drain on US 127 in Owen County (Project NO. DSB-MA 127-1(77)).

CONSTRUCTION

The embankment and cross drain were constructed in two sequences. The west side of the embankment and the inlet end of the culvert were constructed in the first sequence. The pipe was installed by Rifle Coal Company. On November 11, 1996, approximately half of the culvert was installed (36.6 m (120 feet)). The pipe was bedded on approximately 0.46 m to 0.61 m (1.5 to 2 feet) of No. 8 Stone (Figure 1). No. 8 stone was also used to backfill around the pipe (Figure 2). The lifts were constructed and compacted in 0.3-m (1-foot) increments. The pipe was incased with No. 8 stone to a height approximately 0.3 m (1 foot) above the crown of the pipe (Figure 3). The remainder of the embankment was constructed with local bench material consisting of clay and limestone.

Figure 1. No. 8 stone being placed for bedding (1st 120 feet of pipe)

Figure 2. No. 8 stone being compacted around the springline.

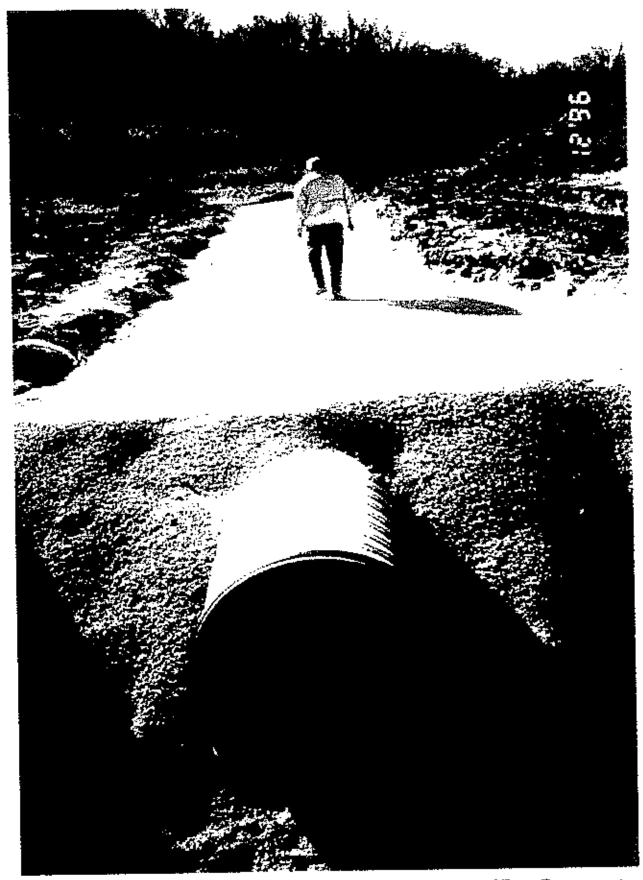

Figure 3. No. 8 stone backfilled to 1-foot above the crown of the culvert.

Prior to the construction of the remaining sections of the culvert, the contractor constructed a temporary retaining structure on the outlet end of the pipe to temporarily hold the embankment away from existing US 127. The structure was constructed of large slabs of limestone that had been exposed and excavated during earth work (Figure 4). Part of the structure had been placed over the outlet end of the pipe. The resident engineer requested that the structure be removed, aware of the possible damages that could be done to the drainage structure. Prior to the removal of the wall, it is apparent that the wall caused some initial damage to the structure. The load on the unsupported end of the pipe caused tension in the crown of the pipe approximately 6 feet back from the outlet end. As a result of the tension, radial cracking had occurred in approximately three areas. The cracks propagated from the crown down to the springline on each side. Employees of ADS repaired (patched) the cracks on April 23, 1997 with an extrusion welder (Figure 5 and 6). To date, the cracks do not appear to be affecting the performance of the structure.

Figure 4. Photo showing remainder of temporary retaining structure which damaged a portion of the culvert.

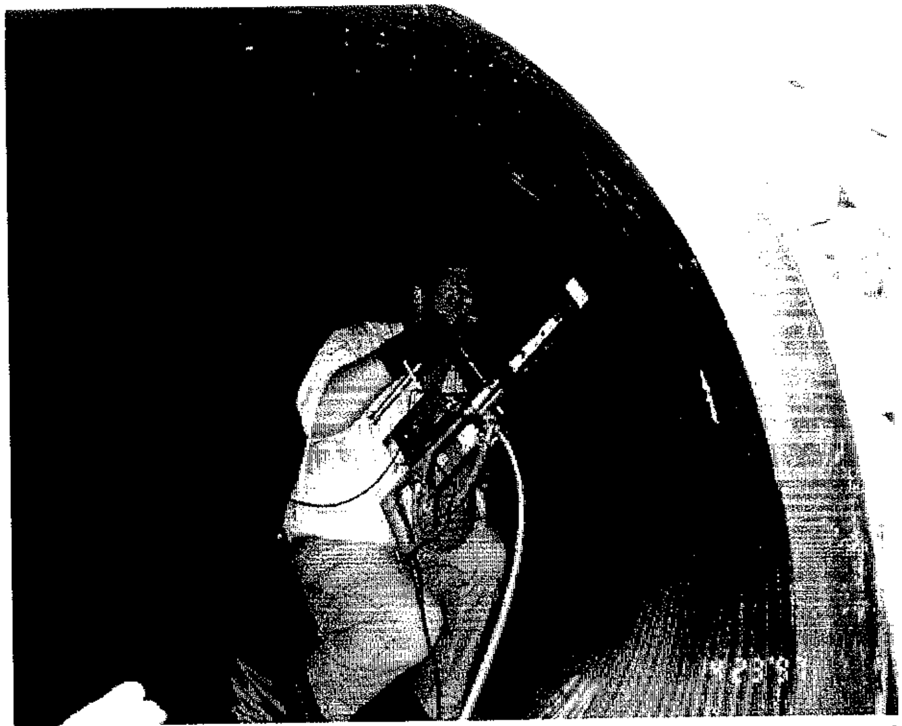

Figure 5. A.D.S. employee repairing damaged section of pipe with extrusion welder.

Figure 6. Photo showing where cracks were repaired with extrusion welder.

On October 21and 22, 1997 the remainder of the cross drain was installed. The pipe was bedded and backfilled with a processed pipe bedding sand made of crushed limestone (Figures 7 - 9). A cross section of the final embankment is shown in Figure 10.

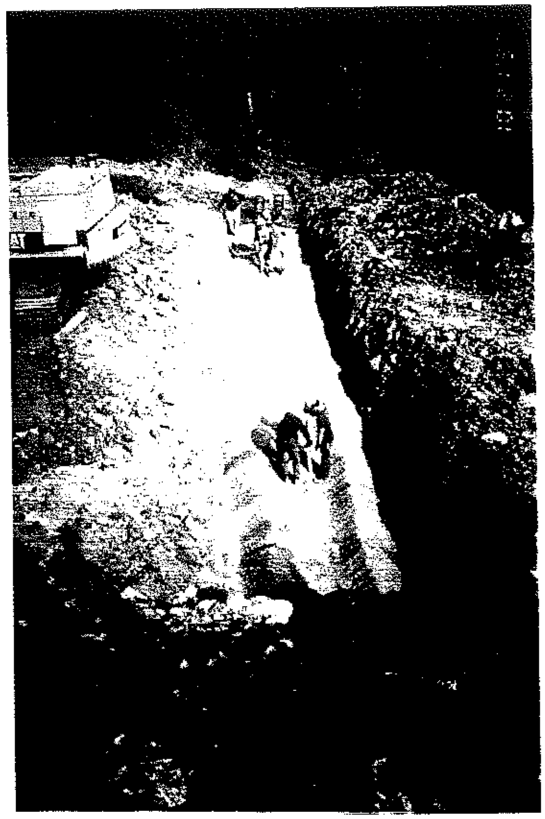

Figure 7. "Pipe sand" bedding being prepared for final section of the culvert.

Figure 8. Final section of culvert being constructed on November 21, 1997.

Figure 9. Final section backfilled with pipe sand to 1-foot above the crown of the pipe.

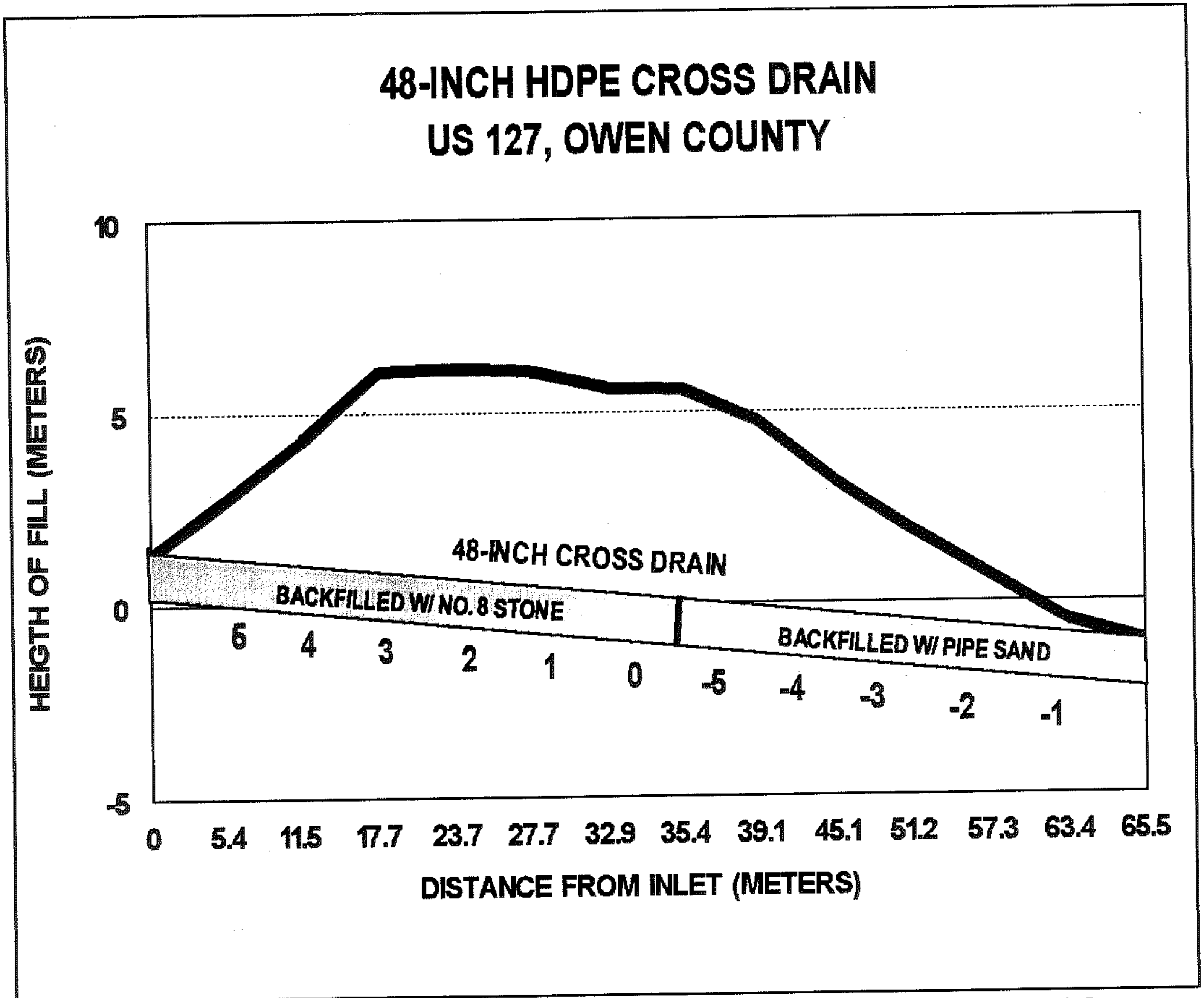

Figure 10. Showing profile of the backfill, monitoring points, and backfill material.

DEFLECTION MONITORING

Monitoring points were placed in each section of pipe prior to backfill. Readings have been taken since construction. The last readings were taken on July 1, 1998. Deflection data are shown in Figure 11 and 12. The maximum pipe deflection recorded was approximately 2.5 percent. It is apparent from the figures that the deflections have stabilized. There also appear to be a slight difference in the performance of the pipe due to the two different backfill materials. Figure 11 indicates that the pipe sections (zero through 5) having backfill with No. 8 stone have slightly less deflection than those sections (-5 through -1) that were backfilled with pipe sand (Figure 12). In addition, the embankment height on the average is higher over the first sections of pipe.

CONCLUSIONS AND RECOMMENDATIONS

The importance of the interaction between the flexible pipe and the backfill cannot be overstressed. To keep the pipe in ring compression, it is critical to provide high shear resistance at the haunches and sides of the pipe. This implies that a material having a large angle of internal friction would provide the best side support for the pipe. Manufactured aggregates are the most appropriate materials to provide and maintain high side resistance. In the case of this installation, a good backfill and bedding material was used resulting in a good installation with low vertical and horizontal deflections. The importance of good backfill is also illustrated in Figure 13 which was generated from computer runs using the Burns and Richard Solution. The solution illustrates that as the strength of the backfill is increased vertical deflections decrease. The solution also indicates that, in the case of this installation, the fill height could have been increased two fold and the deflections would have remained well below the design value of 5 percent. It is recommended that No. 8 stone be used on all flexible pipe installations in the future. It is also recommended that the permissible fill heights for HDPE pipe be increased with the stipulation that processed stone be used for bedding and backfill.

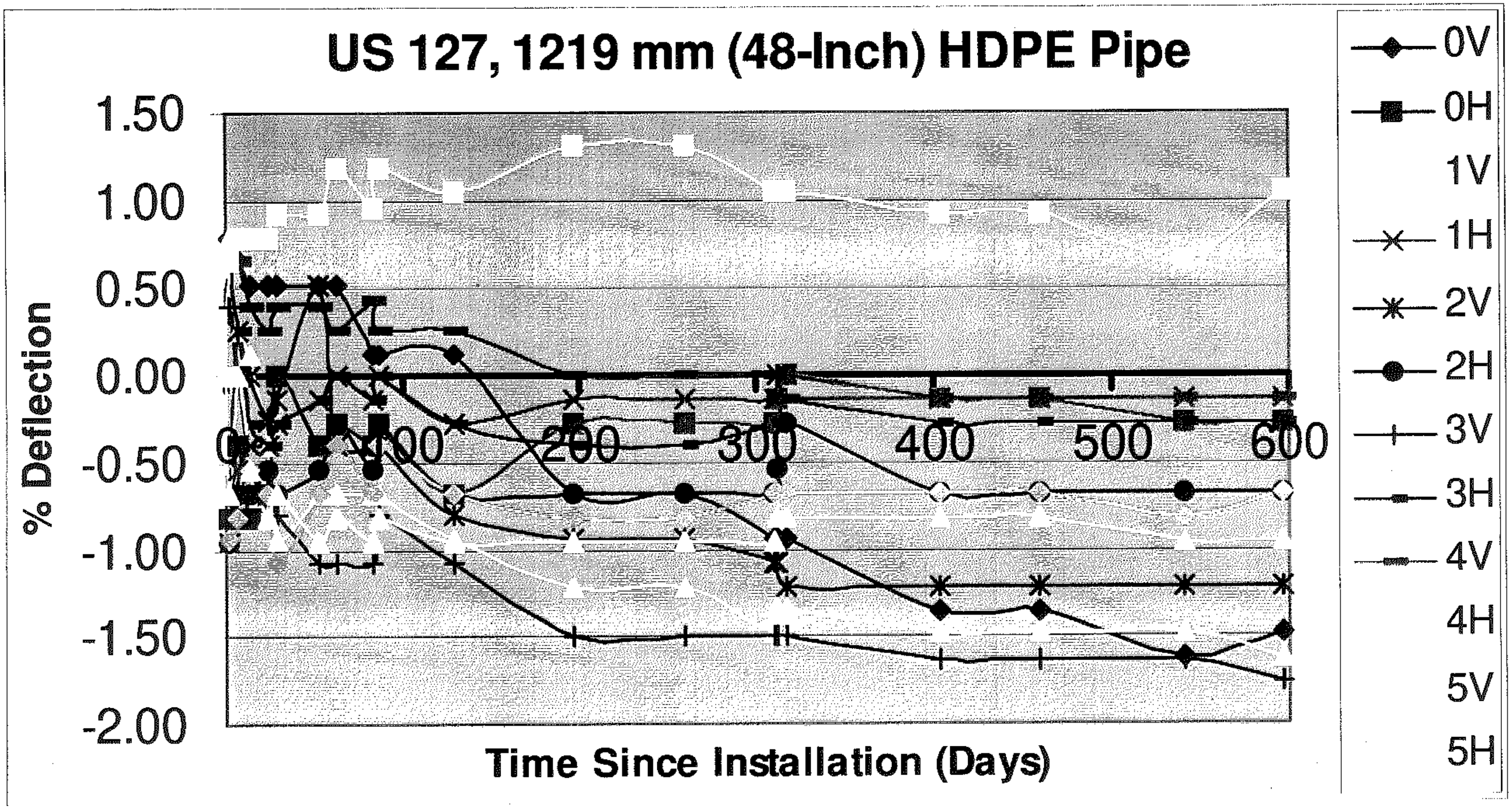

Figure 11. Pipe deflections for pipe sections backfilled with No. 8 stone (monitoring points 0 through 5)

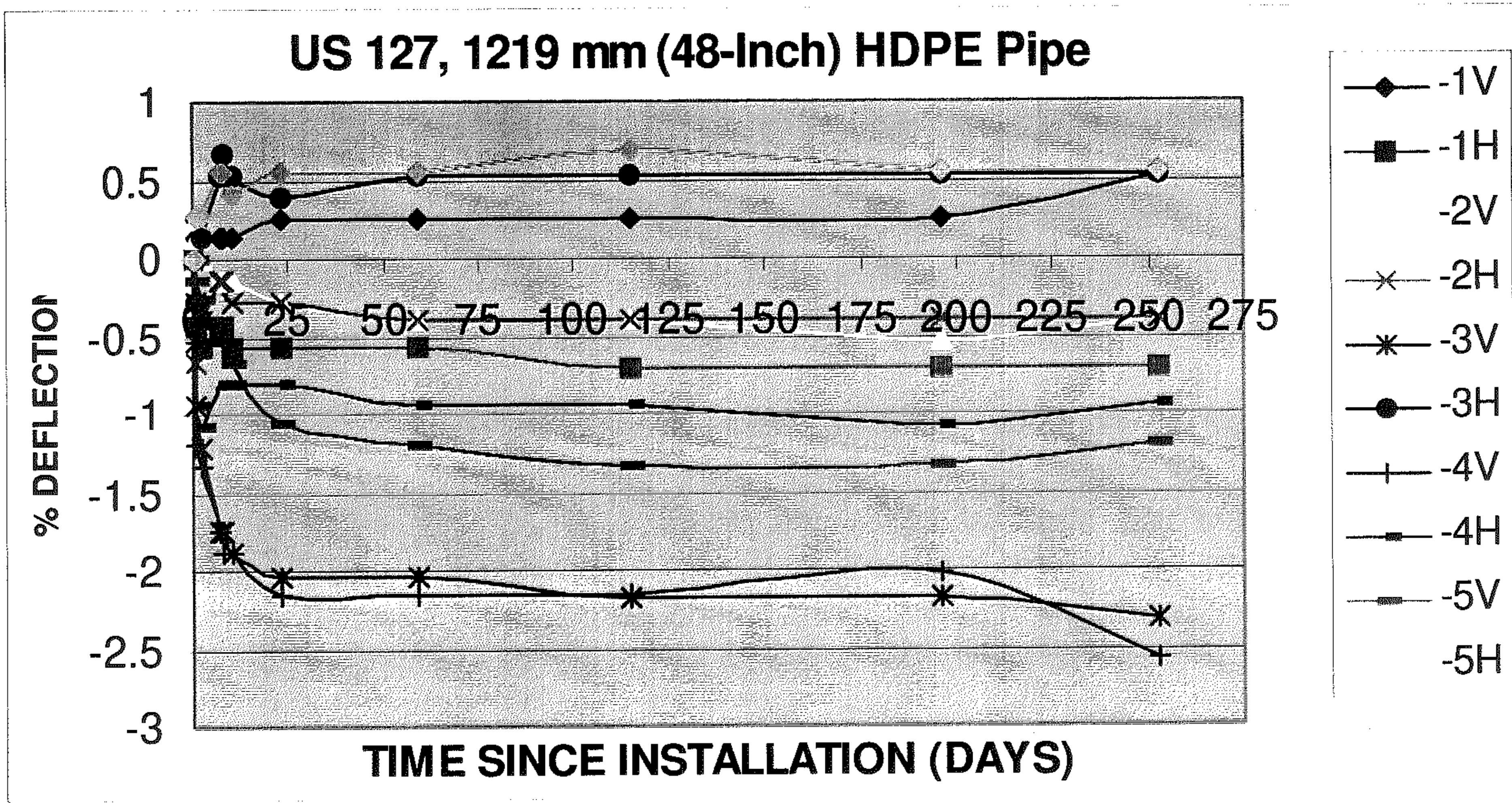

Figure 12. Pipe deflections for pipes backfilled with pipe sand (monitoring points -1 through 5)

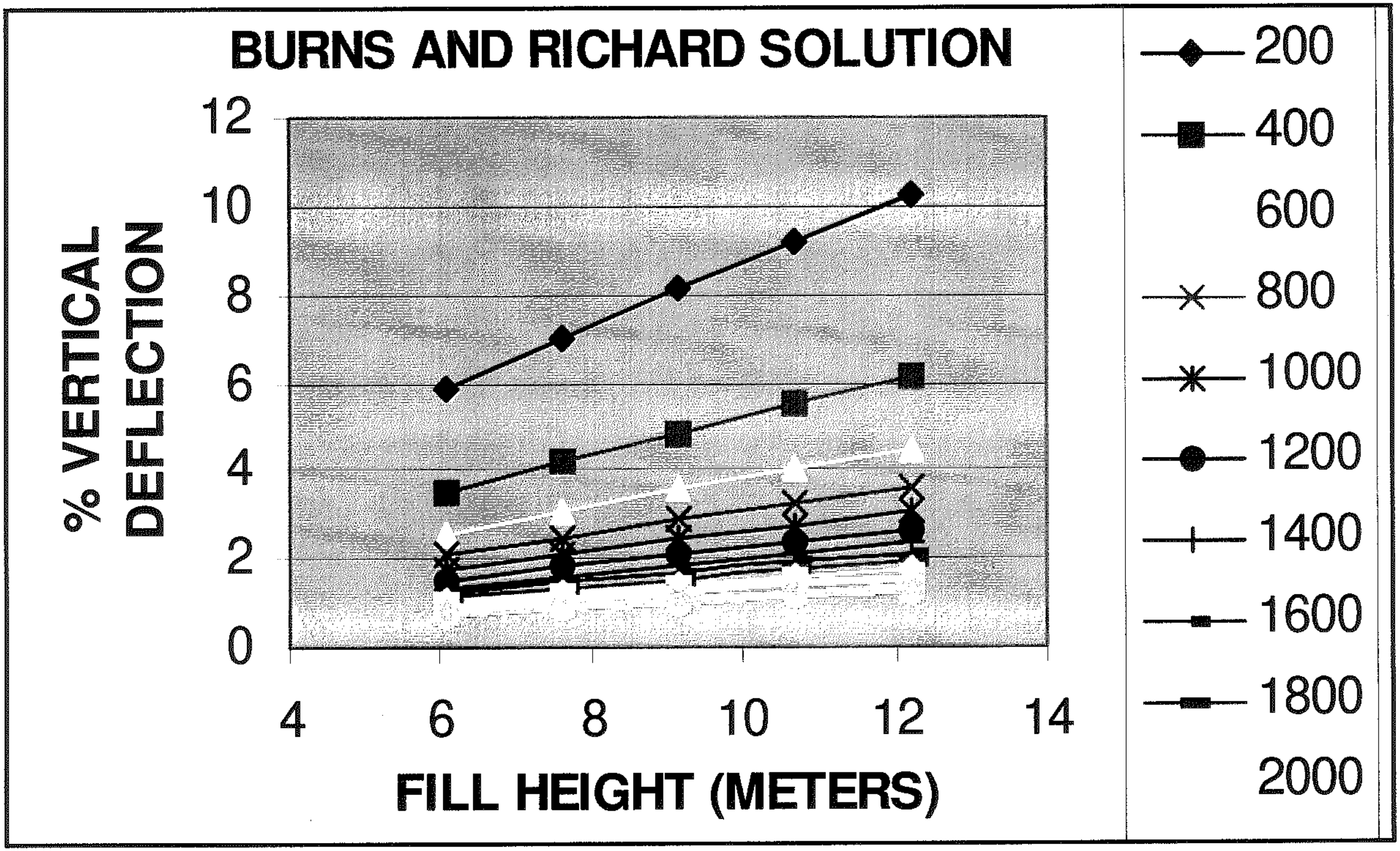

Figure 13. Predicted pipe deflections form Burns and Richard Solution with changing fill heights and backfill strengths.